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Energy Conservation in the National Aviation System

DEPARTMENT OF TRANSPORTATION

Aviation Energy Conservation Policy

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of final policy.

SUMMARY: The purose of this notice is to set forth the final policy of the Federal Aviation Administration with respect to energy conservation in the National Aviation System. The policy represents a comprehensive plan requiring the support of the Federal Government, aircraft owners and pilots, airport operators, and aeronautical manufacturers and suppliers. The policy consists of commitments on the part of the FAA to take specific actions while at the same time it addresses complementary actions needed by non-FAA groups to maximize aviation energy conservation.

DATE: This policy becomes effective January 19, 1981.

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SUPPLEMENTARY INFORMATION:

Background. The FAA issued a Notice of Proposed Policy in the September 22, 1980, **Federal Register** which made available for public comment a draft Aviation Energy Conservation Policy. The policy included a statement of the energy problem facing aviation, a brief discussion of authorities and responsibilities of the various "actors" in the National Aviation System, and a description of the Federal action plan which included 31 actions grouped into the following five program areas:

- Air Traffic Control (ATC)/Flight Operations Programs
- Upgraded ATC Systems and Procedures
- Airport Program
- Aircraft Technology Program
- Internal FAA Program

Several changes were made in the final policy as a result of further review and consideration of public comments. This section will outline the significant changes incorporated into the final policy, and the next section will address the major comments and FAA responses.

The policy document was reformatted to move the chapter entitled "Statement of the Energy Problem" to an appendix. This chapter primarily contains information about energy trends rather than policy responsibilities or actions. The section entitled "Contribution of Air Transportation" in the appendix was modified to include the grounding of fuel-inefficient aircraft and airline purchase of more fuel-efficient aircraft as a major factor contributing to the overall increase in air carrier fuel efficiency. In the "Alternative Fuels Development" portion of the appendix, a sentence was added to mention that the Air Force could be using shale oil jet fuel in the net few years. Also, the discusssion of the hydrogen process was revised to indicated that the manufacturing process now consumes twice (not three times) as much fuel as is produced in the form of fuel.

The chapter on "Authorities and Responsibilities" was expanded to include FAA authority under Executive Order 12185 which provides for energy conservation in the FAA's financial assistance programs. In addition, the section concerning aircraft operators was modified slightly to clarify that the responsibilities listed are for the purpose of conserving energy not to comply with FAA regulations.

The introduction of the chapter entitled "Federal Action Plan" was revised to delete item (a) under the second policy principle which had stated that "The FAA will act to insure aviation's equitable share of energy, by (a) Emphasizing to the public and responsible governmental agencies the importance of aviation to society and aviation's dependence on petroleum-based fuels,..." Item (a) could be construed as promoting aviation for its own sake and not in the public interest. The two remaining items will achieve the same objective by supporting both an efficient allocation of existing petroleum fuels and the development of future aviation fuels. A paragraph was added to the introduction of this chapter to emphasize that the policy commits the FAA to the improvement of the operating environment to "encourage and promote" the use of FAA programs by system users. The policy states that the FAA prefers voluntary cooperative action with industry rather than the regulatory approach to energy conservation. The policy now states that although many of the programs described in the final document have already been implemented to some degree, they are included for the sake of comprehensiveness.

The description of several programs under the Federal Action Plan were revised to emphasize the FAA's commitment to improve the ATC system rather than simply putting the full responsibility on users to accept FAA programs. Quantitative examples of fuel savings were included whenever available.

A program action entitled "Expand Local Flow Traffic Management (LFTM) Program" was added to the ATC/Flight Operations Program to state the FAA's commitment to this ongoing program which minimizes arrival fuel burn.

A paragraph was added to the section on "Effective Use of Airspace" to note the FAA's support of advanced navigation systems and flight management systems. In addition, the paragraph concerning airspace separation goals was modified to clarify that composite separation rules and reduced lateral separation criteria are for oceanic procedures, and reduced vertical separation above flight level (FL) 290 involves both domestic and international airspace.

The section on simulators was revised to clarify that although the existing rule applies only to Part 121 certificate holders, the FAA is considering ways to provide for increased utilization of approved simulators for Part 135 certificate holders and the general aviation community.

The sentence in the section on aircraft maintenance which stated that the FAA would propose alternative procedures to conserve energy was deleted. The aviation industry is taking the lead in this regard, and FAA actions will focus on educating and promoting the use of these procedures; FAA regulations would not provide any additional benefit.

A paragraph was added to the section on training programs for controllers/pilots to mention that in accordance with Executive Order 12185 information will be made available to Aircraft Loan Guarantee Program applicants to encourage them to operate their aircraft in the most fuel-efficient manner. The policy makes it clear, however, that the decision to purchase one aircraft versus another will remain the responsibility of the carrier.

The discussion of the National/Dulles ground operating plan was modified to clarify that the plan will serve as an illustration (not a model) to other airport proprietors of the benefits that may be achieved by similar planning efforts at their own airports.

The section concerning educational programs for airport operators was reworded to clarify that such programs will be developed in consonance with the overall energy conservation effort in the National Aviation System. The programs will emphasize energy-efficient operation of the Nation's airports.

A paragraph was added to the discussion of new technology aircraft

and engines to suppoort the development of avionics as an additional means of conserving fuel.

The section entitled "Develop Fuel-Efficiency Goals for New Aircraft and Engines" was deleted in the final policy. The FAA intended to promote not mandate these goals; however, after consideration of the comments received, we believe such goals would not contribute meaningfully to further increases in fuel efficiency. Further increases in fuel efficiency will require new technology, and the rising price of fuel is providing more then enough incentive for airlines and manufacturers to continue work in this area.

Finally, the summary chart of all the actions has been expanded to show the status of each action, i.e., whether the program is a new initiative, in the development stage, or an ongoing program.

Other minor editorial changes were made where appropriate.

Comments. Several comments were filed in response to the proposed aviation energy conservation policy. The comments indicated widespread support for the concept of energy conservation and the policy in general, but a few comments expressed concern about specific program actions. Following is a summary of the FAA's response to the significant comments filed.

FAA Role. One commenter stated that the FAA's role as the ATC system operator is not defined in the chapter on "Authorities and Responsibilities." On the contrary, the opening paragraph under "The Federal Government" section describes FAA responsibilities in this regard.

Aircraft Operator Responsibilities. One commenter questioned the wording of the section on aircraft operator's authorities and responsibilities as possibly meaning that the operators are responsible to the FAA for the items listed. There is no intention to require the operators to be responsible to the FAA for the items mentioned; the policy was modified to indicate that *for the purpose of conserving energy,* aircraft operators have responsibilities to do their part.

Policy Emphasis. One commenter suggested that the draft policy placed too much emphasis on industry initiatives and too little emphasis on FAA actions. Several modifications were made in the final policy to clarify that for the most part, the policy commits the FAA to the improvement of the operating environment to encourage and promote the use of fuel efficient procedures and programs by aviation system users.

Program Status. One commenter suggested that a definitive schedule for implementing FAA actions be included in the policy. The document is intended to be a policy statement rather than just an action plan. Because schedules are likely to change due to various factors, an implementation timetable is inappropriate for a policy document. However, the document has been modified to include the status of each action (i.e., whether the program is a new initiative, in the development stage, or an ongoing program). Furthermore, for those actions which are ongoing and which will result in a tangible product, an estimated time of completion was added. Another commenter noted that many of the industry initiatives have already been implemented. It is true that several of the policy actions have been implemented to some degree by the FAA or the industry as indicated by the "ongoing program" status in the summary table; they are included in the policy document for the purpose of restating in one comprehensive document the FAA's support of such efforts.

Safety. One commenter noted that energy conservation actions must be predicated on the constraints of safety and the airport geographic and geometric limitations. The FAA concurs, and with regard to the safety issue, the introduction of the Federal Action Plan chapter now states that safety and system efficiency are of primary importance.

Noise Abatement Procedures. To assure that the benefits derived from established and proposed noise abatement procedures are not sacrificed in the interest of fuel conservation, one commenter recommended that the FAA require an environmental impact analysis prior to altering noise abatement procedures. The FAA already requires an environmental assessment for new or revised air traffic control procedures which routinely route air traffic over noise sensitive areas at less than 3,000 feet above the surface.

Local Flow Traffic Management (LFTM) Program. One commenter recommended adding the LFTM program to the list of policy actions. The FAA concurs, and the policy was expanded accordingly.

Fuel-Efficient Altitudes/Speeds. One commenter recommended that the FAA make fuel-efficient altitudes more readily available and consider reduced altitude separation above flight level (FL) 290. The policy provides for both the assignment of fuel-efficient altitudes and the consideration of reduced vertical separation above FL 290. The commenter also noted that there are both safety and economic reasons why a flight may operate off its minimum fuel speed and/or altitude. The FAA recognizes this fact and encourages the use of fuel-efficient procedures, but will not mandate altitudes/speeds at this time.

Effective Use of the Airspace. One commenter correctly pointed out that composite separation and reduced lateral separation are options which are being employed in oceanic operations, and reduced vertical separation above FL 290 is a valid objective for both domestic and international airspace. The final policy clarifies these points.

Tankering. One commenter recommended that the section on tankering be eliminated because there is no role for the FAA in this area. Although air carriers have the primary responsibility in this regard, the FAA can and does emphasize to carriers the fuel inefficiencies which result from tankering. Once again this action is included for the sake of stating in one document FAA's position with regard to tankering.

Aircraft Maintenance. One commenter recommended deletion of the sentence that stated that the FAA would propose alternative maintenance procedures necessary for safety which would also conserve energy. The commenter argued that such action is unnecessary because operators are already motivated to adopt the most fuel-efficient alternatives. Furthermore, alternative procedures have a cost element influenced by factors known only to the operator. The FAA believes that there is no benefit to be derived from alternative FAA regulations, and the sentence in question was deleted from the final policy.

Energy Models. One commenter stated that aircraft manufacturers should have the opportunity to comment on and participate in the development of fuel optimization models and associated data bases. The FAA fully agrees with this statement and believes that industry input is essential to the development of its energy modeling efforts. The FAA continues to coordinate with the aviation community regarding both the development and utilization of its energy models.

Another commenter noted the redundancy of the sections concerning energy models for optimum flight planning and for FAA energy assessments. The policy was revised to delete the redundant section, however, references to energy models remain in two separate areas. The first concerns a model for use by general aviation pilots; the second model will be used by the

FAA for analysis of agency procedures, etc.

Aircraft Loan Guarantee Program (ALGP). Several commenters objected to using the FAA Aircraft Loan Guarantee Progam to dictate equipment choice based on fuel consumption. The commenters agreed that airline selection of new aircraft is a function of the overall economics, not just fuel efficiency. Executive Order 12185: Conservation of Petroleum and Natural Gas requires Federal agencies which administer programs of financial assistance to take actions which maximize the efficient use of energy and conserve natural gas and petroleum in programs funded by those agencies. Accordingly, the FAA will provide information to ALGP applicants which encourages carriers to plan and operate their aircraft in a fuel-efficient manner. The FAA never intended to dictate the choice of aircraft which a carrier must purchase, and the final policy has been modified to state clearly that aircraft choice is and will remain the responsibility of each carrier.

Improved ATC System. Several commenters supported the FAA's actions to improve the efficiency of the ATC System. One commenter suggested that the FAA: (1) present sub-items 1, 2 and 3 under the Integrated Flow Management (IFM) program as objectives not accomplishments; (2) evaluate the fuel conservation potential of the six programs such as the Microwave Landing System (MLS) without endorsing them based solely on energy considerations; and (3) place greater emphasis on designing fuel-efficient departure and arrival routes and profiles. The FAA concurs with these points, and the policy was revised accordingly.

Severe Weather Avoidance System. One commenter recommended that the FAA develop a more accurate system to detect and disseminate information on severe weather. The FAA concurs as indicated by the statement in the policy supporting development of improved weather radar systems in the section on upgraded ATC systems.

Airport Ground Operating Plan. One commenter suggested that the FAA energy-efficient ground operating plan for Dulles and National should not be considered a "model" for other airports because there may be unique features at these two Federally-run airports which would not be applicable to other airports, and vice versa. The final policy was revised to clarify the FAA's intention that the operating plan will serve as an illustration to other airport proprietors of the benefits that may be achieved by similar planning efforts at their own airports.

Quotas and Slot Allocations. One commenter suggested that the FAA consider incentive programs, quotas, etc. only after FAA has taken all appropriate steps to improve the efficiency of the ATC system and reduce delays through other means. The policy already states the FAA's commitment to improving the ATC system and such allocation mechanisms will be evaluated as an additional means to reduce delay.

Another commenter suggested expanding FAR Part 93 to include a mechanism for enforcement of quotas and slot allocations at high-density airports for the purpose of assuring that the established quotas and allocations are not exceeding. FAR Part 93 states that specific quotas may be exceeded in accordance with FAR 93.129 (whenever additional aircraft may be accommodated without significant additional delay to the operations allocated for the airport) or as otherwise authorized by ATC. Controllers are concerned with the safe and expeditious handling of the aircraft operating within their areas of jurisdiction. They usually have little or no interest in the number of operations during the hour or whether or not a particular aircraft has an airport reservation. Decisions to hold or vector aircraft are based upon the air traffic or airport conditions at the moment. Any attempt to restrict hourly operations to a specific number would generate overwhelming administrative and procedural problems.

Aircraft Towing. One commenter recommended deletion of the actions regarding aircraft towing because of the unresolved problems and shortcomings. There may be substantial fuel savings from aircraft towing, and the FAA believes that further study is warranted before the option is discarded. Therefore, the final policy retains the option to continue evaluation of aircraft towing.

Energy Conservation Educational Programs for Airport Operators. One commenter objected to the sentence which discussed the airport operators' ability to use pricing policies to "smooth" peak demand periods and influence aircraft operators' fuel efficiency. The commenter argued that this would be a duplication of (or contrary to) ATC improvements or the slot allocations already mentioned. The commenter argued that educational programs should focus on energy efficient operation of airports. The FAA concurs with the last statement and the policy was revised to indicate that educational programs will emphasize energy-efficient operations and will be part of the overall energy conservation effort in the National Aviation System. However, the policy also states that the educational program may include treatment of the airport operator's ability to influence aircraft operators' fuel efficiency via pricing policies. Such policies would be in addition to ATC system improvements and supportive/consistent with slot allocations, etc.

Fuel Efficiency Goals. Several commenters objected to the establishment of fuel efficiency goals as being unnecessary, confusing, and possibly counterproductive. Rising fuel costs provide more than enough incentive to airlines and manufacturers to improve the fuel efficiency of aircraft and engines. One commenter noted that unlike the auto industry where fuel-efficiency goals may be met in large part with non-technical changes (e.g., downsizing the car and reducing capacity), further fuel efficency gains in the commercial aircraft industry will require technological improvements which cannot be mandated. Although the fuel efficiency goals were never intended to be mandatory targets, the FAA agrees that even voluntary goals are unnecessary. The section on fuel efficiency goals is deleted in the final policy.

Avionics. One commenter suggested that the Integrated Flow Management (IFM) program consider the airborne flight management system (FMS) as part of the total control system. In addition, the commenter recommended expanding the aircraft and engine technology section to include avionics. The FAA concurs, and the final policy specifically addresses avionics as a means of achieving further increases in fuel efficiency.

Air Carrier Fuel Efficiency. One commenter noted that while fuel efficiency of cargo operations is best expressed in ton-miles per gallon, available seat miles (ASM) per gallon would be better for passenger operations. The FAA believes that ASM is not as meaningful because simply flying more seats is not necessarily more efficient; ASM ignores load factors. Passenger miles per gallon would be useful because it accounts for load factors, however, it tracks very closely with ton-miles per gallon; ton-miles has the additional benefit of accounting for cargo as well as passengers.

Another commenter noted that the voluntary grounding of fuel-in-efficient aircraft and airline investment in more fuel-efficient aircraft contributed significantly to increases in air carrier fuel efficiency. The policy has been modified to include this point.

Aviation Fuel Supply Conditions. One commenter noted that the Department of Energy (DOE) fuel allocation system broke down more as a result of airline efforts to dismantle the system than as a result of the Airline Deregulation Act. Regardless of whether the airlines contributed to the breakdown of the DOE allocation system, airline deregulation became "the straw that broke the camel's back" by illuminating the problems with the existing system. The policy statement was not modified concerning this point.

The commenter also objected to the policy assertion that the impact of disclocations resulting in shortages of petroleum products is not more severe for users of aviation fuels than for any other sector of the economy. The commenter argued that ground transportation vehicles have more options than are available to aircraft operators. This reference in the policy concerns short-term supply disruptions. Historically, petroleum shortages have resulted in across-the-board decreases in consumption and except for the 1973–1974 oil embargo the grounding of flights has been rare. The policy clearly states, however, that unlike some other users, aviation is completely dependent on petroleum-based fuels. The FAA therefore supports the policy of insuring an equitable share of petroleum for aviation and other users who do not have any near-term alternatives.

Aviation's Share of Energy. Several commenters supported the FAA's policy to insure aviation's equitable share of energy. One commenter recommended that FAA work with DOE to insure "the highest standby petroleum product allocation for both air transportation and aircraft manufacturing." The final policy states that, ". . . the FAA has no authority to directly regulate the supply or allocation of aviation fuels. . . . Nevertheless, the FAA is routinely involved with the Department of Energy, the International Civil Aviation Organization and other domestic and international agencies regarding actions which impact the supply of aviation fuel . . . " The actions described in the policy are intended to insure a *fair* share of petroleum for aviation in line with national objectives.

Fuel Advisory Departure (FAD) Procedures. One commenter noted that FAD should be implemented at airports with severe delay. The policy states that FAD or similar procedures will be developed in cooperation with industry for other delay-prone airports as it becomes feasible and necessary.

Another commenter noted that FAD should be expanded only after full coordination and that the FAA should assess the performance of the system. The policy reflects both of these points.

Inflight Computers. One commenter suggested that this section be revised to indicate that the ATC system will be evaluated to find ways in which it can accommodate the improved flight operations desired by the operator equipped with the airborne computers. The FAA concurs, and the policy was modified accordingly.

Alternative Fuels Development. One commenter recommended that the discussion of hydrogen manufacturing processes be modified to reflect the potential of updated processes. The policy was revised to state that the hydrogen manufacturing process would consume about twice (instead of three times) as much energy as is delivered in the form of fuel.

Another commenter noted that the Air Force could be using shale oil jet fuel in limited quantities in about two years. The policy was revised to include this point.

Final Policy: In consideration of the foregoing, the following Aviation Energy Conservation Policy is adopted by the DOT/FAA.

DEPARTMENT OF TRANSPORTATION, UNITED STATES OF AMERICA

Aviation Energy Conservation Policy—Office of the Secretary, Federal Aviation Administration, January 19, 1981

Executive Summary

The October 1973 international oil embargo and ensuing events have highlighted the problem of a decreasing petroleum supply in the United States. Aviation is totally dependent upon petroleum, and the price and availability of petroleum products are primary concerns to the fuel-intensive aviation industry.

The Federal Aviation Administration (FAA), in conjunction with the aviation industry, has been actively engaged in developing and implementing programs to conserve aviation fuel since long before the 1973 oil embargo. As a result, aviation fuel efficiency has increased significantly since that time. Despite the improvements already achieved, the need for aviation energy conservation is as great, or greater, today than it was a few years ago. This is especially true because there are no economically viable alternatives to petroleum-based aviation fuels in the near term. As a result, the FAA will promote aviation energy conservation in both the present and future operation of the National Aviation System, and the FAA will act to insure aviation's equitable share of energy.

A comprehensive aviation energy policy will require concerted efforts by all of the "actors" in the National Aviation System including the Federal Government, aircraft operators, airport proprietors, and aeronautical manufacturers and suppliers.

The action plan spelled out in this document consists of 31 actions grouped into the following five program areas:

- Air Traffic Control (ATC)/Flight Operations Program
- Upgraded ATC Systems and Procedures
- Airport Program
- Aircraft Technology Program
- Internal FAA Program

The FAA is responsible for promoting and encouraging fuel conservation by aviation system users and providing a safe, efficient environment within which fuel conservation techniques may be practiced by those users. In this regard, actions in the first program area focus on improving the operating environment through cooperative efforts by ATC controllers and aircraft operators. These include providing/using fuel-efficient speeds, altitudes, maintenance, taxiing, training procedures, etc. to reduce fuel consumption.

The second program area contains research and development efforts and upgraded systems which increase the capacity of the airport and airway system, reduce delay, and improve airspace efficiency. Most of these systems will enhance safety, noise reduction and other FAA goals as well as promote energy efficiency.

The Airport Program includes actions which provide for energy conservation in the design, construction, and operation of airports as well as actions which increase system capacity and reduce airport delay. Airport proprietors benefit from the first kind of actions, and users of the airport and airway system benefit from the latter group.

The primary responsibility for the actions under the Aircraft Technology Program rests with the aeronautical manufacturers and Federal agencies other than the FAA. However, the FAA supports these developments and must insure that future ATC system designs are compatible with new technology aircraft and vice versa.

Finally, the Internal FAA Program includes actions to conserve energy in FAA operations, and to assess the energy impact of FAA programs and procedures on aviation system users.

Taken together these programs provide a meaningful blueprint through which energy savings may be achieved in the National Aviation System.

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I. Introduction

Over the past 25 years, U.S energy consumption has more than doubled. During this period, transportation has consistently accounted for about 25 percent of total U.S. energy consumption. Transportation presently uses 53 percent of the petroleum consumed in the United States.

Total civil aviation consumes about 8 percent of the transportation share of petroleum use or 4 percent of total U.S. petroleum. All aviation energy is supplied by petroleum fuels at the present time. Research is being done to develop alternative fuels, however, alternate fuels for aviation do not appear to be economically feasible or available in large quantities in the near term. During the past ten years, the energy consumption of commercial aviation increased 25 percent. In the next ten years, fuel requirements for air transportation are expected to rise another 25 percent.

The October 1973 oil embargo by the Organization of Petroleum Exporting Countries (OPEC) and ensuing events have highlighted the problem of a decreasing petroleum supply. The price and availability of petroleum products are primary concerns to the fuel-intensive aviation industry especially the commercial air carrier sector. Air carrier fuel consumption increased 4.7 percent between 1973 and 1979; fuel prices rose 331 percent during the same period. Fuel costs account for 30 percent of operating costs in the aviation industry. Thus, the continuing development of fuel-efficient aircraft and air traffic control operating techniques and technological improvements to aircraft and the air traffic control system are of paramount importance to the health of the industry.

The Federal Aviation Administration (FAA) has long recognized the need for energy conservation in aviation, and FAA energy conservation efforts predate the OPEC embargo. In March 1972, the need for energy efficient aircraft was stressed in the FAA's National Aviation System Policy Summary. The FAA Administrator followed up by calling a Consultative Planning Conference entitled "The Energy Outlook for Aviation" which convened in October 1973.

As a result of prior planning, the aviation community was able to respond immediately when the OPEC embargo was announced on October 19, 1973. The FAA implemented a seven-point jet fuel conservation plan on November 20, which was designed to save almost 4 percent of the total amount of jet fuel consumed by the domestic airlines. The FAA, working closely with the aviation industry, has continued to pursue a dedicated program to conserve fuel in the operation of the Nation's airport and airway system.

The Energy Policy and Conservation Act (EPCA), Pub. L. 94–163, signed by the President on December 22, 1975, was designed to promote energy conservation in all national sectors. One of the mandates of the *EPCA* was a 10 percent improvement in energy conservation over 1972 preembargo levels. As a result of the prior commitment of the FAA and the aviation community to energy conservation, domestic commercial aviation fuel efficiency, measured in Revenue Ton-Miles Per Gallon (RTM/G), had already improved 16 percent when the *EPCA* became law. This trend has continued as evidenced by the 35 percent increase in RTM/G from 1972 to 1979.

Despite the improvements already achieved, the need for aviation energy conservation is as great, or greater, today than it was a few years ago. The Department of Transportation is responsible for promoting the most efficient means of transporting people and goods be it by air, rail, ship, or highway. Consistent with the Departmental mission, the FAA is committed to the development of the most efficient aviation system possible, both to contribute to the national goal of saving energy and to provide efficient and competitive service. Therefore, the FAA has developed a comprehensive policy on aviation energy which includes a list of options which are directly within the purview of the Federal Government. Additionally, this document spells out specific actions which should be pursued by the aviation industry including the air carriers and general aviation, airport proprietors, and aeronautical manufacturers and suppliers. The full benefit of a Federal plan of action will be realized only when complementary action is taken by all participants.

The next section of this document, Chapter II, briefly outlines the authorites and responsibilities of the various "actors" in the National Aviation System. Chapter III describes the Federal action plan in detail ending with a summary table of all the programs. The Appendix provides in greater detail an understanding of the energy problem facing aviation including an overview of historical, current, and future trends of U.S. energy consumption with particular emphasis on the U.S. civil aviation industry. In addition, the importance of aviation to the national economy, the prospects for the aviation fuel supply, and the feasibility of using alternate fuels for aviation are discussed.

President Carter in his November 8, 1977, energy message to the Nation, stated, "This energy plan is a good insurance policy for the future, in which relatively small premiums that we pay today will protect us in the years ahead. But if we fail to act boldly today, then we will surely face a greater series of crises tomorrow—energy shortages, environmental damage, even more massive government bureaucracy and regulations, and ill-considered last-minute crash programs." The President was talking specifically about his energy plan for the Nation, however, his comments also pertain to energy conservation programs within the National Aviation System. This document is intended to be an insurance policy which will contribute to the health and viability of the U.S. air transportation system.

II. Authorities and Responsibilities

The Federal Government is responsible for promoting and encouraging fuel conservation by aviation system users and providing a safe, efficient environment within which fuel conservation techniques may be practiced by those users. This responsibility belongs primarily to the Federal Aviation Administration which installs, operates, and maintains the components of the National Airspace System and ensures the safe and expeditious flow of air traffic through the system. The FAA has the authority to regulate the safety of aircraft operating procedures, revise and expand the air traffic control system, provide

financial support through the Airprt and Airway Trust Fund to airport operators, and support the research, engineering, and development of new technology related to air traffic control systems and aircraft. In additon, the FAA operates two Federally-owned airports, Washington National and Dulles International. These reponsibilities provide a variety of opportunities for affecting aviation fuel conservation.

Existing legislation gives the Secretary of Transportation and the FAA Administator discretionary authority to issue certain kinds of rules and regulations in forms that may conserve fuel and other resources. However, the FAA has no specific authority to directly regulate the production, allocation or consumption of fuel at this time. For example, Section 103 of the Fedral Aviation Act of 1958 empowers and directs the Secretary and the Administrator to regulate civil and military operators in the interest of safety and efficiency, and Section 307(a) explicitly mandates the development of plans and the formation of policy to insure the efficient use of navigable airspace. In certain cases, the attainment of efficiency objectives may result in substantial fuel savings.

The Department of Transportation Act in Section 2(a) describes the policy objective as the development of national transportation programs conducive to efficient and convenient transportation consistent with "the efficient utilization and conservation of the Nation's resources." Additionally, the National Environmental Policy Act in Sections 101(b)(5) and 105 authorizes every Federal agency to develop and improve its programs so as to "achieve a balance between population and resource use."

Executive Order 12185, Conservation of Petroleum and Natural Gas, which implements section 403(b) of the Powerplant and Industrial Fuel Use Act of 1979 requires Federal agencies which administer programs of financial assistance to take actions which maximize the efficient use of energy and conserve natural gas and petroleum in programs funded by those agencies. In this regard, DOT/FAA has the authority to encourage energy conservation in the Airport Development Aid Program (ADAP)[1] and the Aircraft Loan Guarantee Program, both administered by the FAA.

Beyond these legislative mandates, the President's energy message of June 29, 1973, directed all departments and agencies to work closely with the Energy Office to develop long-term conservation plans. The Secretary of Transportation was specifically directed to work with the FAA, the Nation's airlines, and the Civil Aeronautics Board to conserve fuel. Furthermore, the mandated role of the FAA in aviation energy conservation policymaking is consistent with the current Administration's emphasis on energy conservation, and it requires the FAA to provide leadership in a national effort to reduce aviation fuel consumption and improve aviation energy efficiency.

Other agencies which impact aviation system users include the Department of Energy (DOE), the Civil Aeronautics Board (CAB), the National Aeronautics and Space Administration (NASA), the Department of Defense (DOD), the Federal Highway Administration (FHWA), and the Urban Mass Transportation Administration (UMTA). The latter two agencies are interested in the promotion of energy-efficient landside access to airports.

Prior to the Airline Deregulation Act of 1978, the CAB regulated fares and route structures for the air carrier industry. Load factors and route structures can have a significant impact on an airline's energy efficiency. Although airline deregulation has granted the carriers greater flexibility in setting fares and selecting routes, the CAB still retains some regulatory authority in these areas. The evidence thus far seems to indicate that airline deregulation is conducive to air carrier fuel conservation since the 1979 level of fuel efficiency (RTM/G) has continued to rise under that system. Deregulation allows air carriers to rationalize their route structures and to employ their aircraft fleet more efficiently.

NASA, in cooperation with industry, is primarily responsible for Federally-funded research in the development of alternative aviation fuels and new technology aircraft, aircraft systems, and engines. Because of the significant progress already achieved from improved operating procedures, new technology aircraft engines will provide the greatest potential for further gains in aviation energy efficiency. DOD is also working in the area of alternative aviation fuels especially with regard to military jet aircraft.

Aircraft Operators, including the air carriers and general aviation, are the primary users of the airport and airway system. For purposes of conserving energy, their responsibilities include the efficient utilization of existing aircraft and fuel resources through effective scheduling, optimum flight planning, and use of safe fuel-conserving operating procedures. Furthermore, as soon as it becomes economically feasible, aircraft operators and management should replace older, fuel-inefficient aircraft with new technology aircraft which improve the overall fuel efficiency of their fleet. Rising fuel prices provide a strong incentive for all users of the system to reduce fuel consumption and to pursue self-initiated actions complementary to Federal actions in overall aviation energy conservation.

Airport Proprietors are responsible for the energy efficient design and operation of airport facilities. Airport delays result in excess fuel consumption by users of the system. Therefore, airport operators can also impact the fuel consumption of airport users by installing facilities which maintain or expand system capacity at otherwise congested airports.

Aeronautical Manufacturers and Suppliers are responsible for the research, development, and manufacture of more fuel-efficient engines, airframes, and avionics equipment. NASA studies estimate that future aircraft and aircraft engine designs could be as much as 50 percent more fuel-efficient than current high bypass ratio engines and will generate substantial fuel savings for the aviation industry when they are utilized.

III. Federal Action Plan

Department of Transportation/Federal Aviation Administration (DOT/FAA) policy supports the use of the most efficient means of transporting people and goods be it by air, rail, ship or highway. The improved efficiency of all those modes is a common objective.

Consistent with the need for an aviation energy policy and the FAA's responsibility to provide leadership in this area, this chapter describes FAA actions concerning aviation energy. The following two policy principles provide the basis for action in this regard.

1. The FAA will promote aviation energy conservation in both the present and future operation of the National Aviation System, by

(a) Supporting development and use of energy-efficient aircraft and aircraft operating techniques;

(b) Promoting the energy-efficient operation of the airport and airspace system; and

(c) Conserving energy in the design, installation and operation of FAA system facilities and aircraft.

2. The FAA will act to insure aviation's equitable share of energy, by

(a) Supporting the short-term development and use of alternative fuels in other areas whenever possible in an effort to free petroleum-based fuels for aviation, and other users, which are

[1] The authority to obligate funds under ADAP expired on September 30, 1980. However, for purposes of this policy document, it is assumed that some form of airports grant program will be enacted by the Congress in the future.

vital to the Nation and for which there are no economically viable alternatives in the near term; and

(b) Supporting longer-term R&D efforts for development of future alternative aviation energy fuels.

As stated in the previous chapter on authorities and responsibilities, the FAA has no authority to directly regulate the supply or allocation of aviation fuels. Instead, FAA actions primarily impact users of aviation fuels. As a result most of the actions discussed in this chapter implement the first policy principle which emphasizes conservation and improved efficiency rather than expanding the supply of aviation fuel. Nevertheless, the FAA is routinely involved with the Department of Energy, the International Civil Aviation Organization, and other domestic and international agencies regarding actions which impact the supply of aviation fuel consistent with the second policy principle.

The actions outlined below include a mix of voluntary, incentive, and mandatory programs to be pursued by the Federal Government as well as the aviation community. For the most part, the policy commits the FAA to the improvement of the operating environment to "encourage and promote" the use of energy conserving procedures and programs on the part of aviation system users. The FAA prefers voluntary, cooperative action with industry whenever possible rather than the regulatory approach to energy conservation. In addition, many of these actions have already been implemented to some extent by the FAA or the industry, but are included for the purpose of restating in one comprehensive document the FAA's support of such efforts.

The specific actions are grouped into the following five program areas which together result in a comprehensive energy conservation effort:

- Air Traffic Control (ATC)/Flight Operations Programs
- Upgraded ATC Systems and Procedures
- Airport Progam
- Aircraft Technology Program
- Internal FAA Program

The programs do not fall neatly within the purview of any single participant. For example, the FAA can implement many or all of the options in the ATC/Flight Operations Program, however, the success of these options depends on the extent to which aircraft operators cooperate to conserve fuel. Futhermore, the Federal Government can support measures which fall into the Aircraft Tehnology Program, but the decision to purchase new aircraft will be made by the air carriers or other aircraft operators with possible influence from Federal action. One final caveat is that as mentioned earlier, the FAA is responsible for insuring the *safe, expeditious* flow of air traffic; the energy conservation programs outlined below will, of course, be implemented only after considering, as a minimum, their impact on safety and system efficiency.

A. ATC/Flight Operations Program

The FAA is responsible for promoting and encouraging fuel conservation by aviation system users and providing a safe, efficient environment within which fuel conservation techniques may be practiced by those users. Studies suggest that the greatest source of improved aviation fuel efficiency under the direct control of the FAA is in the optimization of the airport and airway system. The aviation fuel inefficiencies resulting from system delay alone can offset many of the benefits of improved scheduling, flight planning, operations, and fleet optimization achieved by system users. The FAA recognizes this fact, and many of the following program elements describe existing and planned FAA actions which are designed to improve the efficiency of the airport and airway system. To supplement these FAA actions this program also includes actions which require the cooperative efforts of ATC controllers and aircraft operators. In some instances, tradeoffs exist between fuel conservation and noise reduction. Accordingly, FAA noise abatement initiatives and flight procedures will be implemented only after consideration of their impact on aviation energy conservation goals. Specific program elements falling under the ATC/Flight Operations Program include the following:

Refine and Expand Fuel Advisory Departure (FAD) Procedures

FAD procedures are designed primarily as a fuel savings effort during extended periods of arrival delays. FAD transfers airborne delay to ground delay (thereby saving fuel) by altering actual aircraft departure times at the departure airports consistent with acceptance rates at the arrival airport. For example, a B727 uses 19 gallons per minute in cruise, 8.3 gallons per minute on the ground (idling), and 1.7 gallons per minute at the gate (with auxiliary power unit (APU)). FAD procedures are used at Chicago and Denver, and a similar program is scheduled for the New York metropolitan area.

Aircraft operators currently elect to accept FAD and gate hold procedures when there are excessive delays in the system, however, they are not required to do so. The FAA will continue to improve the accuracy of its delay estimates under FAD in an effort to promote greater use of the system. In addition, the FAA will develop a monitoring system to assess the performance of the system at both FAD and non-FAD airports to determine the efficiency of the procedures. Similar procedures will be developed in cooperation with industry for other delay-prone airports as it becomes feasible and necessary.

Promote Gate Hold Procedures

Similar to FAD procedures, the objective of gate hold procedures is to eliminate nonproductive fuel use by holding aircraft at the airport loading gate with engines off when departure delays exceed 5 minutes. Again, a B727, holding with engines on consumes 8.3 gallons per minute versus 1.7 gallons per minute with the APU. The FAA will continue to promote the use of gate hold procedures. Programs such as gate hold procedures, which conserve aviation fuel in groundside operations, may also reduce aircraft noise and pollutants around airports.

Expand Local Flow Traffic Management (LFTM) Program

With the assistance of representatives from pilot and industry groups, the LFTM program was introduced by the FAA to minimize arrival fuel burn. The success of the LFTM program lies in the metering of traffic into the terminal environment at a specific airport acceptance rate commensurate with capacity and the maximum application of fuel efficient descents and approach procedures from cruising altitude/flight level to the approach gate. The procedure is designed to absorb any necessary delays at or beyond the metering fixes using altitudes at flight level 200 and above rather than at low altitudes. These delays may be absorbed by vectoring, speed adjustments, or holding. Distribution of delays are more equitable as a result of these techniques. The LFTM program has been implemented at approximately 188 major airports throughout the United States. The LFTM program will be implemented to the maximum extent possible at all airports that serve turbojet or large turboprop aircraft.

Promote Fuel-Efficient Altitudes/Speeds

The fuel consumption of an aircraft depends on several factors including cruise altitude, speed and weight. FAA policy concerning assignment of aircraft altitudes presently states that whenever possible the requested altitudes will be

approved. Similar to the current situation with regard to altitude assignments, aircraft operators select their own cruise speeds. The following example illustrates the impact of speed on aircraft fuel burn. At 25,000 feet, a reduction in cruise speed of a medium weight B727 from .82 Mach to .8 Mach reduces fuel consumption by 1.3 percent; further reduction to .78 Mach decreases fuel consumption an additional 1.1 percent.

Each model of aircraft has its own fuel-efficient parameters of altitude and speed depending on several variables including weight, temperature, winds aloft, etc. It would be difficult to develop regulations that could cover all types of aircraft yet be specific enough to enforce. Also, all controllers would have to be aware of each airplane's fuel-efficient altitude/speed which would add to their current responsibilities. As a result, agency actions will emphasize to pilots the importance of fuel-efficient altitudes/speeds but will not propose regulations in this area. Furthermore, the FAA will emphasize to controllers the need whenever possible to assign the most fuel-efficient altitude when requested.

Promote Effective Use of the Airspace

The FAA supports the development and use of advanced navigation systems and flight management systems as a means of achieving significant fuel conservation. These systems allow users to fly optimal routes through, for example, area navigation (RNAV) and use more fuel-efficient climb and descent procedures.

In another area, users are often required to accept fuel use penalties to maintain separation minima in the interest of safety in the airspace. The penalties are incurred when the aircraft is assigned a non-Optimum track or altitude because of potential conflicting traffic. The adjustment of the configuration of routes or reduction of separation standards is a complex process involving detailed studies and extensive coordination. There is, however, evidence based on recent improvements in specific areas that beneficial changes can be realized. The FAA intends to continue work in this area within budgetary restrictions with specific goals to include:

(1) establishment of general rules for application of composite separation in accordance with International Civil Aviation Organization (ICAO) rules for oceanic procedures;

(2) development of reduced lateral separation criteria for operations where users show compliance with improved minimum navigation performance requirements for oceanic procedures; and,

(3) the reduction of vertical separation above flight level (FL) 290 to 1,000 feet for both domestic and international airspace.

Promote Reduced Tankering

Because of differing prices and availability of fuel at various airports, aircraft operators sometimes carry more fuel than that needed for a particular flight. "Tankering" is fuel-inefficient because more fuel is burned in flight due to the added weight of the tankered fuel. For example, for a specific set of values for speed, altitude, weight, etc., a B727 uses 3,400 gallons of fuel on a 824 mile trip. With other things being equal, that same aircraft would consume an additional 428 gallons of fuel (13 percent more) to tanker an additional 3,400 gallons of fuel. Accordingly, the FAA encourages air carriers to avoid carrying excessive quantities of fuel unless dictated by availability. In addition, the FAA will encourage all carriers to establish and maintain an airline fuel logistics program aimed at the elimination of the need for tankering.

Expand Use of Simulators

The increasing size, complexity, and operating costs of the modern turbojet transport in its operating environment emphasizes the need for greater use of the advanced technology now available in aircraft simulators. In response to this need, the FAA issued the rule, effective July 30, 1980, entitled "Advance Simulation." The rule, which amended Parts 61 and 121 of the Federal Aviation Regulations, provides guidelines and a means for achieving total flightcrew training, checking, and certification in advanced simulators. It is estimated that 32,000,000 gallons of fuel could be saved per year if air carriers use advanced flight training simulators in lieu of aircraft for transition and upgrade training. Over 73,000,000 gallons could be saved per year if the advanced simulation plan is fully implemented. Although the rule applies only to Part 121 certificate holders, the FAA is considering ways which would provide for increased utilization of approved simulators for Part 135 certificate holders and the general aviation community. The major considerations for the individual small operator or pilot school regarding the feasibility of incorporating an FAA-approved simulator in its training program would be the degree of simulator sophistication required for approval, the initial cost of the simulator, and the resultant economic benefits based on the reduced number of flight-hours derived from use of the simulator.

Promote Fuel-Efficient Taxi Procedures

In many instances, certain aircraft operating on the ground do not need to use all of the engines on the aircraft. Fuel can be saved by shutting down one or more engines for taxiing. This practice is currently used by all users to some extent. The FAA encourages greater use of fuel-efficient taxi procedures where these procedures are shown to increase system efficiency. In addition, the FAA will encourage airport proprietors to design their runways and taxiways in such a way as to provide for the greatest fuel conservation potential given the constraints of safety, etc.

Promote Maintenance of Aircraft for Optimum Fuel Efficiency

The way an aircraft is maintained can have an impact on its fuel efficiency. Many of the carriers are already taking advantage of maintenance programs to conserve fuel, and FAA actions will focus on educating all users to the benefits of such programs.

Promote Use of Inflight Computers

A computer on-board the aircraft optimizes fuel utilization by permitting optimum flight planning, monitoring aircraft health, and performing other functions which result in fuel-efficient performance of the aircraft. The FAA will evaluate the ATC system to determine how best to accommodate the improved flight operations desired by operators equipped with airborne computers.

Develop Energy Model for Optimum Flight Planning

The FAA is developing a fuel burn model suitable for application in a programmable, hand-held calculator for use by general aviation pilots. The calculator will enable pilots to plan their flights and make inflight revisions for minimum fuel consumption.

Expand/Promote Energy Training Programs for Controllers/Pilots

The FAA will revise its air traffic control training programs to include a greater emphasis on fuel conservation measures for system users which are impacted by ATC procedures and programs. In addition, the FAA will require that controllers implement specific energy conservation programs and procedures at particular locations and/or systemwide consistent with safety, efficiency and environmental considerations. This will ensure that the latest innovations in fuel-conserving

techniques are available to system users.

The FAA is developing a compendium of fuel burn curves based on information provided by aircraft and engine manufacturers that depict the fuel efficiencies of various aircraft at specific speed, altitude, and weight configurations. This information, which will show the most energy efficient set of operating curves by aircraft type, will be updated and expanded to include additional aircraft types as such information becomes available. These data will be made available to aircraft operators to assist them in their energy planning.

In this regard, Executive Order 12185, Conservation of Petroleum and Natural Gas, directs Federal agencies to conserve energy in the application of financial assistance programs. Accordingly, the FAA encourages applicants under the Aircraft Loan Guarantee Program to operate their aircraft in the most fuel efficient manner utilizing such information as the fuel efficient operating curves mentioned above. These data will be made available to carriers for their information; however, the decision to purchase one aircraft versus another will, of course, remain the responsibility of each carrier.

The FAA will continue to encourage the development of fuel conservation programs by air carriers and general aviation operators and pilots. A number of procedures and techniques developed in coordination between GAMA (General Aviation Manufacturers' Association) and the FAA are now being made available to the aviation consumer public by the various news media and through aviation education programs in connection with the FAA's Accident Prevention Program. FAA approved pilot training schools and certificated flight instructors are being encouraged to emphasize fuel conservation measures where such measures can be safely utilized. In this context, new ideas will be explored and acted upon where feasible and practicable.

By promoting energy conservation educational programs for air traffic controllers and aircraft operators, the FAA ensures that all "actors" in the National Airspace System are aware of the most fuel-efficient programs and procedures.

B. Upgraded ATC Systems and Procedures

The FAA has recently initiated the Integrated Flow Management (IFM) program whose function is to define requirements for, and assure functional integration of, engineering and development (E&D) activities impacting traffic flow. While the IFM program is primarily related to E&D activities, it takes cognizance of other on-going programs within the agency which can potentially impact traffic flow. The objectives of the IFM program are to assure that:

(1) Existing airport/airspace resources are best used under the physical constraints of aspects such as runway capacity, spacing restrictions and weather.

(2) Aircraft delays are mimimized and necessary delays are absorbed as fuel efficiently as possible.

(3) Best overall use is made by ATC system users of sophisticated avionics (such as Flight Managment Systems) on many air carrier, commuter and business aircraft.

The basic premises inherent in the IFM program are:

(1) Aircraft operators will increasingly urge the FAA to make optimum use of procedures and equipment which provide for aircraft fuel conservation.

(2) The ATC system will continuously be required to efficiently handle a wide mix of aircraft in terms of performance, size, weight, and speed.

(3) The introduction of sophisticated flight managment computers (FMC) will rapidly redefine the airbone environment in terms of what profiles aircraft operators desire, and will be able, to fly.

(4) Improved automation aids for planning and execution of ATC operations will significantly improve traffic flow management. Availablility of these aids will become increasingly more advantageous as more variables are introduced into the decisionmaking process, satellite airports are upgraded, and expanded use is made of special purpose runways at major hubs.

(5) Changes to procedures and airspace structures will best take place if the users, designers (including airframe manufacturers), and operators of the system are involved in the development process and if such changes are proven to have merit and be workable.

In addition to and in conjunction with the IFM program the FAA will evaluate the potential fuel conservation benefits of ATC facilities and systems such as:

Wake Vortex Advisory System (WVAS)

Tower Automated Ground Surveillance (TAGS)

Advanced Automation (Enroute Radar Automation)

Microwave Landing System (MLS)

Discrete Address Beacon System (DABS) and its data link

Redundant Critical NAS Elements

Most of these upgraded systems will enhance safety, noise reduction, and other FAA goals as well as promote energy efficiency.

Severe weather accounts for a significant amount of the delay at our Nation's airports. The FAA will support development of improved weather radar systems to define more accurately areas of hazardous weather. This will mimimize aircraft diversions and reduce weather-related delays thereby conserving fuel.

The FAA will ensure that departure and arrival routes and profiles in the terminal area are designed to mimimize fuel burn within the constraints of safety and noise abatement. Further capability in this area will be provided by development of state-of-the-art automation aids, procedures, and aircraft equipment. The design and development of these profiles will be carried out under the umbrella of the IFM program.

C. Airport program

The Airport Program includes actions which provide for energy conservation in the design, construction, and operation of airports as well as actions which increase system capacity and reduce airport delay. Airport proprietors benefit from the first kind of actions, and users of the airport and airway system benefit from the latter group. Specific program elements falling under the Airport Program include the following:

Require Energy Assessments for ADAP Projects

The Airport Development Aid Program (ADAP) is a Federal financial assistance program which provides a means for promoting energy efficiency and conservation. This opportunity to promote conservation was underscored by Executive Order 12185: Conservation of Petroleum and Natural Gas, dated December 17, 1979, which directed Federal agencies to institute rules designed to achieve energy conservation through the implementation of financial assistance programs. The FAA has adopted a rule which requires recipients of ADAP funds to perform an energy assessment for each Federally-assisted building construction or major building modification which exceeds $200,000 in construction cost. The rule also requires airport sponsors to utilize energy conservation practices in the operation and maintenance of the airport. The regulation allows for the consideration of energy factors during the planning process, i.e., an element of a systems plan or master plan covering energy

impacts would be eligible for Federal assistance when it is found to be a reasonable and necessary part of the plan. Such planning is not required under this regulation, but is encouraged by the FAA.

As a result of this rule, energy efficiency in the design, planning, and operation of airports is included as a criterion for ADAP funding. Airport operators/owners will benefit from the reduced energy consumption of the airport facilities. To promote further conservation the FAA is developing technical guidance which will be available in the spring of 1981 to help airport operators comply with the rule. In addition, the FAA encourages energy conservation in the design and operation of hangars and other airport facilities for which the air carriers or other users are responsibile.

Develop Energy-Efficient Ground Operating Plan for Washington National and Dulles International Airports

The Federal Government owns and operates Washington National and Dulles International Airports. The FAA has underway a study to evaluate the energy conservation potential at these two airports of actions that fall within the purview of the airport proprietor (e.g., airport access, operation of ground vehicles, location of facilities, etc.). Based on the findings of this study, the FAA intends to develop an energy efficient ground operating plan for these airports. Additionally, the operating plan will serve as an illustration to other airport proprietors of the benefits that may be achieved by similar planning efforts at their own airports. The agency will also establish a monitoring system to measure the fuel savings which result from specific techniques at National and Dulles.

Promote Snow/Ice Removal Systems

The time required to open runways after a snowfall is highly variable, depending upon the intensity of the snowfall and the availability of snow-ice removal equipment. In 1979, 22.6 percent of delays of 30 minutes or more was due to snow and ice problems. The FAA encourages airport operators to purchase snow/ice removal equipment and such equipment is eligible for Federal funding under ADAP.

Evaluate Incentive Programs, Quotes and Slot Allocation Mechanisms for Reducing Airport Delays

One of the primary causes of fuel inefficiency in the National Aviation System is delay. The FAA is committed to improving the ATC system, and many of the options already mentioned are designed to expand capacity and reduce delay. However, another way to minimize or eliminate delay problems is through incentive programs which reduce demand or better utilize existing capacity. For example, by improving its delay estimates, the FAA will encourage users to use FAD procedures. The FAA could also issue delay projections that are specific to a facility at a congested airport. For instance, there may be significant delays on one runway, but another shorter runway at the same airport may be available without any delay. Aircraft operators with the appropriate equipment may be able to land on the second runway without any adverse effect on the primary facility thus expanding system capacity. Facility-specific delay projections may encourage more aircraft operators to purchase equipment which can operate on secondary runways at congested airports. The FAA will evaluate the feasibility of using such incentive-type programs and procedures to reduce demand or expand capacity.

There are currently four airports at which the FAA has established a reservation system to relieve excessive congestion. The four airports are Washington National, J.F. Kennedy, LaGuardia, and Chicago O'Hare Airports. The agency has imposed an hourly limit on IFR operations (arrivals and departures) by class of users. The FAA will evaluate the potential for reducing system delay and conserving fuel by expanding hourly quotas to other congested airports.

The FAA is evaluating several potential slot allocation mechanisms for use at Washington National Airport. The results of this analysis may be used at other delay-prone airports which have substantial peak demand patterns.

Continue the Airport Improvement Program to Reduce Congestion and Delays

In 1977, the FAA established the Airport Improvement Program in an effort to reduce aircraft delays at the Nation's 25 busiest airports. This program was patterned after a comprehensive delay study conducted at Chicago O'Hare International Airport in the mid-1970's. Since 1977, Airport Improvement Working Groups have been established at nine other major airports. The Airport Improvement Program is structured to bring local expertise to bear on the problems at each airport, while at the same time coordinating these local efforts in a national program to reduce congestion and delays throughout the National Airspace System. The program is jointly sponsored by the FAA and the Air Transport Association, and has been publicly endorsed by the Administrator and Deputy Administrator.

Promote Satellite Airports and Separate General Aviation Facilities at Congested Airports

The FAA promotes the use of satellite airports and the construction and/or dedication of separate general aviation runways, where possible, at congested airports. Currently, the mix of aircraft in terminal areas requires complex separation standards to avoid the wake vortex problem. To the extent that traffic can be separated by aircraft type, aircraft spacing can be decreased and airport capacity increased. The resulting delay reduction may conserve significant amounts of fuel. On August 7, 1979, the FAA anounced a major new program to upgrade air safety in 56 metropolitan areas by improving airport facilities at 86 satellite fields. Eventually as many as 236 satellite airports in 75 metropolitan areas could be affected.

Evaluate Aircraft Towing

Another area which requires further analysis is the potential fuel conservation benefits and costs of extended towing of aircraft in the terminal area. The Department of Energy and the FAA are evaluating this option which involves technical and operation feasibility and safety questions that need to be solved. The FAA will continue to evaluate this alternative as well as promote other measures to decrease groundside fuel use such as taxiing on fewer engines whenever safety permits.

Develop Energy Conservation Educational Programs for Airport Operators

Educational programs for airport operators will be developed and distributed nationwide in consonance with the overall energy conservation effort in the National Aviation System. The programs will emphasize energy-efficient operation of the Nation's airports. The FAA will also publish, in conjunction with the ADAP requirement mentioned earlier, technical guidance concerning the energy-efficient design, construction and operation of ariports.

In a different vein, the program may include treatment of the airport operator's ability to impact the fuel efficiency of airport system users through the use of pricing policies which "smooth" the otherwise peak demand for slots at congested airports.

Promote Energy-Efficient Airport Access Systems

The Federal Highway Administration and the Urban Mass Transportation Administration are involved in landside access to airports in conjunction with State or local governments. To support their efforts, the FAA encourages the use of mass transit and other energy efficient transportation modes for airport access, including access to Washington National and Dulles International Airports. This may include the use of vanpools by airport employees, etc.

D. Aircraft Technology Program

The primary responsibility for the actions under this program rests with the aeronautical manufacturers and Federal agencies other than the FAA. However, the FAA supports these developments and must insure that future ATC system designs are compatible with new technology aircraft and vice versa. Specific program elements falling under the Aircraft Technology Program include the following:

Promote Development of New Technology Aircraft, Engines, and Aircraft Systems

As a result of the 1973/1974 oil embargo and the rapidly rising price of aviation fuel, aircraft operators have taken advantage of capacity and operating changes which conserve fuel. Therefore, significant increases in fuel efficiency for the future will require technological improvements in aircraft, aircraft engines, avionics, and the ATC system. New technology aircraft and aircraft engines will, in fact, generate the greatest savings in fuel in the long term.

NASA has the primary responsibility for developing future airframe and engine designs. One response to this responsibility is NASA's Aircraft Energy Efficiency Program which focuses on developing basic improvements in technology to enhance the energy efficiency of existing and future aircraft. This program has several phases. The Engine Component Improvement Program is directed towards existing engines such as the JT9D, CF6, and JT8D. This program is geared towards detailed improvements to engine components and also includes a diagnostic effort aimed at identifying and eliminating the major causes of performance degradation over the engine lifetime. The purpose of the Energy Efficient Engine Program is to provide an advanced technology base for a generation of fuel-efficient turbofan engines for commercial transports. Additionally, NASA's advanced turboprop project is directed at establishing the feasibility of radically improved propellor propulsion systems. The propfan may be able to combine the fuel efficiency of a propellor with the speed capability of current turbofan-powered transports. In still another area, NASA is working on aerodynamic and structural technology improvements which have a direct application to future fuel-efficient aircraft. Finally, the FAA is working with NASA to reduce wake vortices at their source through aircraft modifications. This would permit reduced separation standards thereby increasing system capacity. The FAA will support these developments and insure that future ATC system designs are compatible with new technology aircraft, and vice versa.

Aircraft and avionics manufacturers and NASA are developing avionics such as the Flight Management System (FMS) for fuel-efficient flight operations in the ATC system. The FAA supports this research and the IFM program described in section B, above, includes defining an environment which allows users to take full advantage of sophisticated avionics.

Promote New Aircraft Designs with Extended Towing Capabilities

If studies concerning aircraft towing prove successful, the FAA will promote the design of new aircraft or modifications to existing aircraft to permit safe and efficient extended towing capabilities. As noted earlier, extended towing of aircraft in the terminal area could reduce groundside fuel consumption, but there are safety and operational issues which first need to be resolved.

Support Development of Alternative Fuels

The discussion of alternative fuels contained in the Appendix concludes that there are no economically viable alternatives to conventional petroleum-based aviation fuel in the near term. The stability of an aviation fuel supply will require the development of new fuels in the future. NASA, DOD, and DOE have the primary responsibility in this area. NASA's work is in the area of developing technology to accommodate alternative fuels for future commercial and general aviation aircraft. DOD is performing R&D on utilization and defining fuel specifications for use in military turbine aircraft. DOE's role with regard to alternative fuels is primarily oriented to R&D on extraction, upgrading, and refining, and commercialization of alternative fuels. The FAA will monitor the progress in alternative fuels developent in the interest of maintaining an effective air transportation system. The FAA also has underway studies to determine the feasibility of using automotive gas in lieu of aviation gas for general aviation and, to a lesser extent, air carrier operations.

Consistent with one of the policy principles states at the beginning of this chapter, the FAA will promote the use of alternative fuels whenever possible in an effort to free petroleum-based fuels for aviation, and other users, which are vital to the Nation and for which there are no economically viable alternatives in the near term.

E. Internal FAA Program

Specific program elements falling under the Internal FAA Program include the following:

Promote Efficient Use of Energy in FAA Operations

The FAA will adopt standards, policies and internal operating procedures which accomplish the following:

- Improve the efficiency of "process" facility electrical use through solid-state equipment technology.
- Improve the efficiency of motor gasoline use in maintenance and other day-to-day operations.
- Improve the efficiency of jet fuel and aviation gas use in FAA aircraft fleet operations.
- Improve the efficiency of heating and cooling energy use in both manned and unmanned FAA facilities.

Develop Energy Contingency Plan

The FAA is developing an appendix to its agency Order 1900.1C, FAA Emergency Operations Plan. The appendix provides for energy contingency planning to ensure to the maximum extent possible a continuing support capability of FAA facilities and installations during periods of energy supply deficiencies or short-term outages.

The FAA will also work towards the development of a mechanism which provides for contingency planning for the aviation industry in the event of a serious fuel crisis. The FAA will support the national objective of maintaining an effective air transportation system to the extent necessary for national security.

Promote Energy Efficiency in ATC Facilities

The FAA will review its establishment criteria for en route and terminal facilities (funded under the facilities and equipment program) to

ensure that energy efficiency is given proper emphasis.

Require Energy Assessment for Agency Actions

On December 11, 1980, the FAA issued an order revising its internal regulatory procedures to require an energy assessment for those FAA actions which involve by design, construction, installation or operation the significant use of energy in their function or implementation. In general, energy assessments will be performed for the following areas: (1) establishment of buildings, including those used for navigation equipment, (2) changes to air traffic control regulations, policies, or procedures which would clearly cause a significant increase in aircraft fuel consumption, (3) airport layouts or changes to an airport layout, and (4) aircraft modifications. The FAA's operating regulations are included in (2) above, and as a result this requirement will ensure that the energy impact of FAA noise abatement procedures as well as other agency actions and decisions are considered before implementation. Energy conservation will not take precedence over the safety mandates of the FAA, but whenever possible, safety-oriented actions will be consistent with the agency's energy conservation activities.

Develop Energy Models for Use in Energy Assessments

The FAA is developing several analytical tools and data bases which will improve agency capabilities in performing energy assessments. One such tool is an aircraft fuel burn simulation model which assesses aircraft-specific fuel consumption characteristics of complex flight patterns en route and in terminal areas around airports. The model, which will be available in the summer of 1981, will facilitate the energy impact analysis of: (1) proposed changes to operating procedures, (2) airport delay effects. and (3) regulatory changes.

Furthermore, this model will be linked to the FAA's noise model to ensure that analyses of noise abatement programs consider the impact of those programs on aviation energy conservation goals.

Monitor ATC Energy Conservation Programs

The FAA will establish a monitoring program to measure the impacts of various ATC programs on energy use. This will provide information on the effectiveness of existing energy conservation programs and provide the basis for future planning in the area of energy. This is a complex issue since many FAA programs are interrelated and it is impossible to identfy the actual energy savings which result from any single program. Also, there are many participants involved in the decisionmaking process—air traffic controllers, aircraft operators, airline managements, etc. For this reason, inplementation of a monitoring system will require the coordinated efforts of all participants to identify those programs which feasibly can be measured and to design the most appropriate monitoring mechanism for each program. For those programs where the resource commitment necessary to monitor agency programs is too large to justify a monitoring system, the FAA will use fuel savings estimates based on analytical models.

Summary

The FAA Aviation Energy Conservation Policy represents a comprehensive plan requiring the support of the Federal Government, aircraft owners and pilots, airport operators, and aeronautical manufactureres and suppliers. It consists of commitments on the part of the FAA to take specific actions while at the same time it addresses complementary actions needed by non-FAA groups to maximize aviation energy conservation.

The following chart lists all of the actions contained in this policy document. In addition, the chart identifies the various groups, Federal and private, which are responsible for the actions and the status of each.

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PROGRAM/ACTION	RESPONSIBLE GROUPS	New Initiatives	Development Stage	Ongoing Program
A. ATC/Flight Operations Program				
1. Expand and Refine Fuel Advisory Departure (FAD) Procedures	FAA, Aircraft Operators, Airport Operators			X
2. Promote Gate Hold Procedures	FAA, Aircraft Operators, Airport Operators			X
3. Expand Local Flow Traffic Management (LFTM) Program	FAA, Aircraft Operators, Airport Operators			X
4. Promote Fuel-Efficient Altitudes/Speeds	FAA, Aircraft Operators			X
5. Promote Effective Use of the Airspace	FAA, Aircraft Operators		X	X
6. Promote Reduced Tankering	FAA, Aircraft Operators			X
7. Expand Use of Simulators	FAA, Aircraft Operators		X	X
8. Promote Fuel-Efficient Taxi Procedures	FAA, Aircraft Operators, Airport Operators			X
9. Promote Maintenance of Aircraft for Optimum Fuel Efficiency	FAA, Aircraft Operators			X
10. Promote Use of Inflight Computers	FAA, Aircraft Operators			X
11. Develop Energy Model for Optimum Flight Planning	FAA, Aircraft Operators, Aeronautical Manufacturers		X	X
12. Expand/Promote Energy Training Programs for Controllers/Aircraft Operators	FAA, Aircraft Operators	X		

PROGRAM/ACTION		RESPONSIBLE GROUPS	New Initiatives	Development Stage	Ongoing Program
B.	Upgraded ATC Systems and Procedures	FAA, Aircraft Operators, Airport Operators, Aeronautical Manufacturers		X	X
C.	Airport Program				
1.	Require Energy Assessments for ADAP Projects	FAA, Airport Operators	X		
2.	Develop Energy-Efficient Ground Operating Plan for Washington National and Dulles International Airports	FAA	X		
3.	Promote Snow/Ice Removal Systems	FAA, Airport Operators			X
4.	Evaluate Incentive Programs, Quotas and Slot Allocation Mechanisms for Reducing Airport Delays	FAA, Airport Operators, Aircraft Operators		X	X
5.	Continue the Airport Improvement Program to Reduce Congestion and Delays	FAA, Airport Operators, Aircraft Opeators			X
6.	Promote Satellite Airports and Separate GA Facilities at Congested Airports	FAA, Airport Operators, Aircraft Operators			X
7.	Evaluate Aircraft Towing	FAA, Airport Operators, Aircraft Operators, Aeronautical Manufacturers		X	X
8.	Develop Energy Conservation Education Programs for Airport Operators	FAA, Airport Operators	X		
9.	Promote Energy-Efficient Airport Access Systems	FAA, UMTA, FHWA, Airport Operators			X

PROGRAM/ACTION	RESPONSIBLE GROUPS	New Initiatives	Development Stage	Ongoing Program
D. Aircraft Technology Program				
1. Promote Development of New Technology Aircraft Engines, and Aircraft Systems	FAA, NASA, Aeronautical Manufacturers, Aircraft Operators		X	X
2. Promote New Aircraft Designs with Extended Towing Capabilities	FAA, Aeronautical Manufacturers, Aircraft Operators, Airport Operators		X	X
3. Support Development of Alternative Fuels	FAA, DOE, NASA, DOD		X	X
E. Internal FAA Program				
1. Promote Efficient Use of Energy in FAA Operations	FAA			X
2. Develop Energy Contingency Plan	FAA	X		
3. Promote Energy Efficiency in ATC Facilities	FAA			X
4. Require Energy Assessment for ATC Facilities and Procedures	FAA	X		
5. Develop Energy Models for Use in Energy Assessments	FAA, Aircraft Operators, Aeronautical Manufacturers		X	X
6. Monitor ATC Energy Conservation Programs	FAA	X		

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Appendix: Statement of the Energy Problem

In the United States, 87 percent of transportation energy is derived from petroleum. Aviation is totally dependent on petroleum which is becoming an increasingly scarce resource in the United States. As a result, the United States has become dependent on imported petroleum, and therefore, is more vulnerable to uncertainties in both the domestic and international marketplace.

This section provides an overview of historical, current, and future trends of U.S. energy consumption with particular emphasis on the U.S civil aviation community. In addition, the importance of aviation to the national economy, the prospects for the aviation fuel supply, and finally, the feasibility of using alternate fuels for aviation are discussed briefly. These facts will clarify the need for a comprehensive aviation energy conservation effort by the Federal Government and the aviation industry.

National Energy Perspective

Figure 1 illustrates the breakdown of U.S. energy consumption by type of energy. U.S. energy consumption has more than doubled over the past 25 years, and transportation has consistently accounted for approximately 25 percent of all energy consumed. Transportation presently uses 53 percent of the petroleum consumed in the United States.

Although domestic petroleum production is 8.7 million barrels per day or 23 percent of total energy use, it is far exceeded by the demand for petroleum products which is 17.6 million barrels per day. The result is an over-dependence on imported petroleum products. Focusing directly on petroleum, Figure 2 shows petroleum consumption by major sectors of the economy, and Figure 3 shows the transportation share by mode. As is evident from these statistics, transportation is very vulnerable to fluctuations in petroleum supplies.

Aviation Fuel Perspective

Total civil aviation consumes about 8 percent of the transportation share of petroleum use or 4 percent of total U.S. petroleum. The table below shows the estimated fuel consumption for domestic civil aviation for FY–1980.

FIGURE 1

Total U.S. Energy Consumption By Type of Energy

1979 Percentages

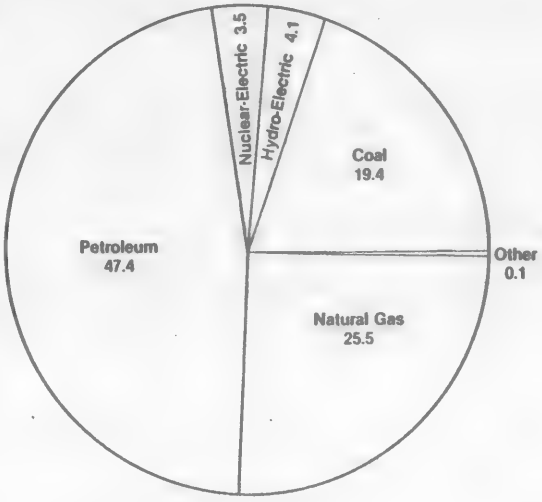


FIGURE 2

Use of Petroleum Products By Major Sectors of the Economy

1979 Estimated Data by Percent

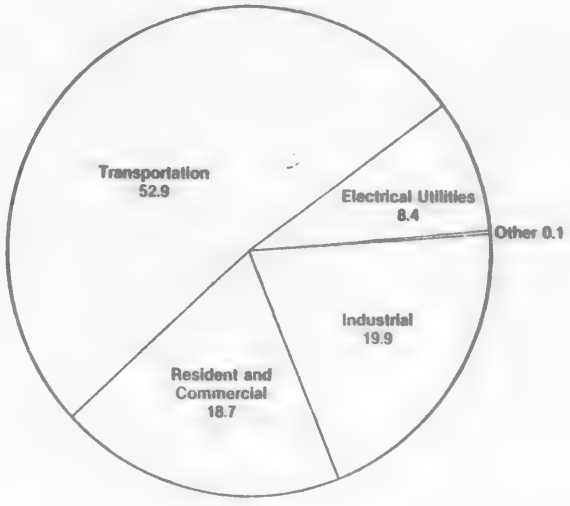
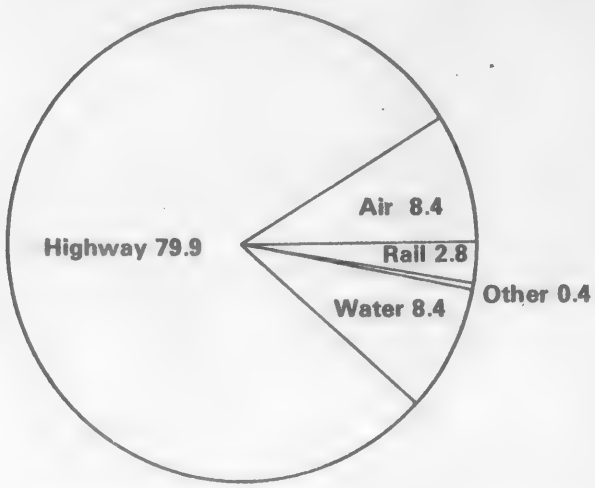


FIGURE 3

Transportation Petroleum Consumption By Mode

1980 Estimated Data by Percent



Estimated U.S. Domestic Civil Aviation Fuel Consumption—FY 1980

[Millions of Gallons]

	[illegible]	General aviation	Total
Jet fuel	10,370	909	11,279
Aviation gas	13	[illegible]	535
Total aviation fuel	10,383	1,431	11,814

Air carriers consume 88 percent and general aviation consumes 12 percent of domestic civil aviation fuel. At current levels of consumption, a one percent savings in commercial aviation fuel would yield a total annual savings to the Nation of about 100 million gallons. At an average price of $1.00 per gallon, this would translate into a savings of about $100M a year to the airlines. This indicates that effective fuel conservation programs can have a significant impact on national consumption and airline profitability.

Historical data (Figure 4) show that domestic air carrier fuel consumption dropped significantly after the oil embargo of 1973 which forced airlines to cut back their flight frequency to conserve fuel. Fewer gallons consumed coupled with an increasing level of revenue ton-miles resulted in improved fuel efficiency (see Figure 5). Current fuel consumption has risen in response to the significant growth in air carrier traffic (air carriers consumed 4.7 percent more gallons in 1979 than in 1973).

As shown below, air carrier fuel prices have risen about 546 percent since 1973 for domestic carriers and 654 percent for international carriers. A significant portion of the increase occurred in 1974 as a result of the oil embargo. Even though the air carriers have exhibited increasing fuel efficiency, the continued increases in fuel prices (which are beyond management control), have cause the proportion of total operating costs attributable to fuel costs to rise substantially.

Average Air Carrier Fuel Prices and Operating Costs

	1973	1974	1975	1976	1977	1978	1979	(1st half) 1980
Domestic operations:								
Price (cents per gallon)	13	32	27	30	35	39	[illegible]	84
Percent of total operating costs	11	15	16	18	20	20	24	30
International operations:								
Price (cents per gallon)	13	34	36	37	40	[illegible]	84	98
Percent of total operating costs	11	21	21	20	20	19	25	30

[illegible] CODE 6315-15-M

FIGURE 4

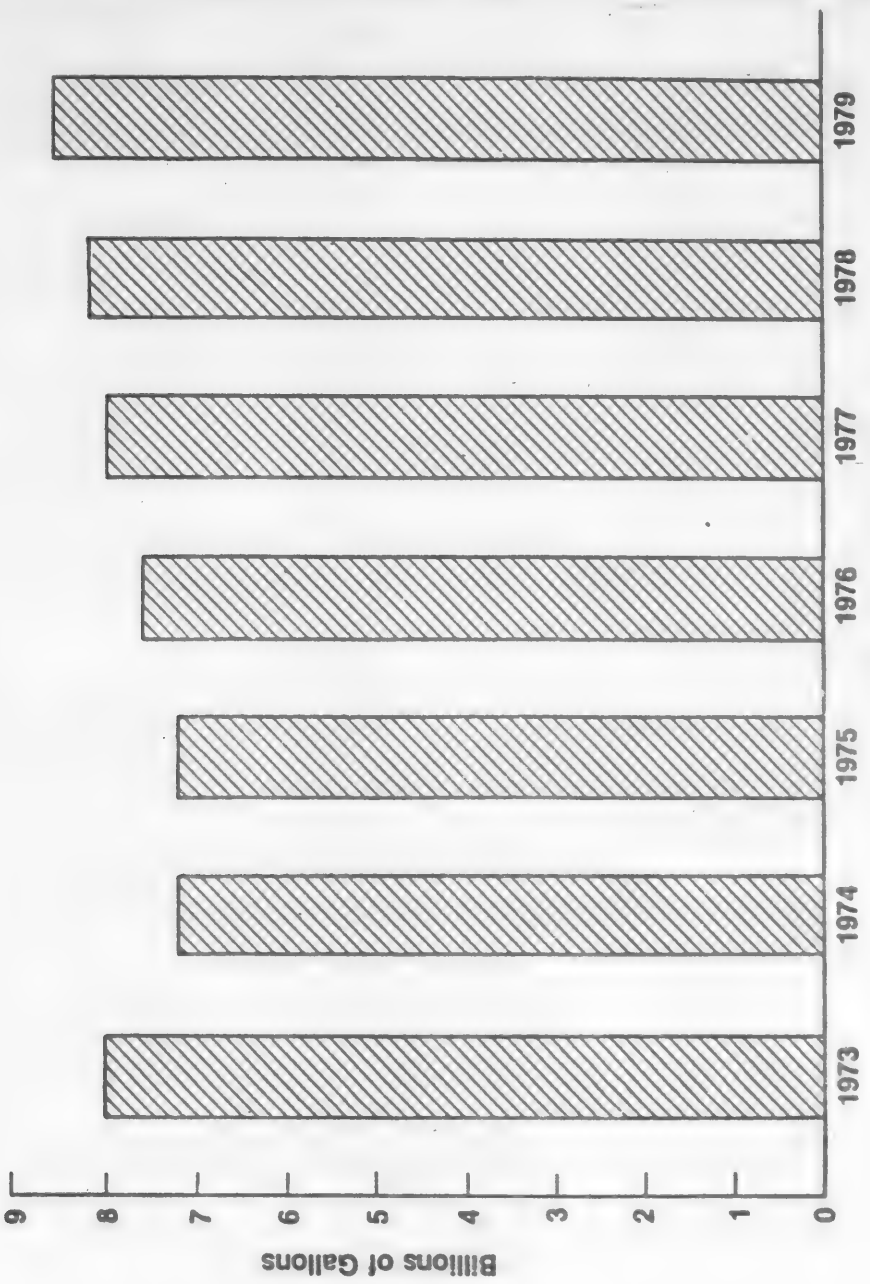
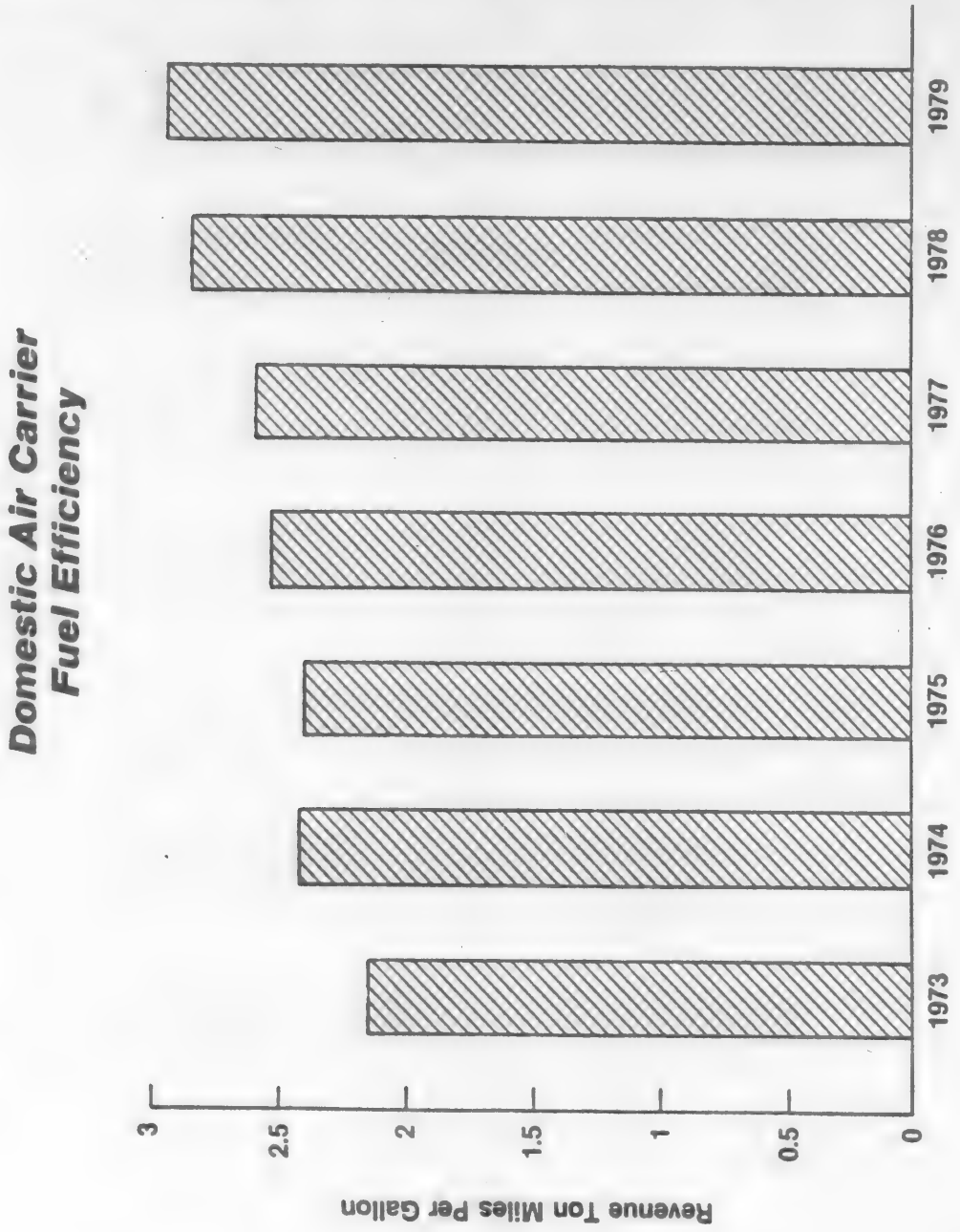

Domestic Air Carrier
Fuel Consumption
1979
1978
1977
1976
1975
1974
1973
0
1
2
3
4
5
6
7
8
9
Billions of Gallons

FIGURE 5



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General aviation fuel consumption has increased steadily since FY–1973 with jet fuel consumption growing at a faster rate than aviation gasoline. Of special interest to general aviation activity is the fact that in FY–1980 only 6,000 aircraft of the 193,000 general aviation fleet used jet fuel, accounting for only 8 percent of hours flown. However, this accounted for 64 percent of total general aviation fuel used. As general aviation operators turn to greater use of jets, fuel consumption will undoubtedly increase at a faster rate than otherwise.

Average General Aviation Fuel Prices

(Cents per Gallon)

Fuel	1973	1974	1975	1976	1977	1978	1979	1980
80/87	47	64	69	75	82	89	128	154
100/130	49	66	73	76	84	91	130	151
Jet Type A	50	62	66	69	76	79	136	143

General aviation fuel prices have risen approximately 228 percent and 186 percent for aviation gasoline and jet fuel, respectively, since 1973. In spite of these cost increases, general aviation itinerant operations and hours flown increased almost 46 percent and fuel use increased 100 percent over the same period.

Forecast of Aviation Activity

The FAA's baseline forecasts of aviation activity assume that the supply of energy and fuel will not significantly inhibit economic or aviation growth. Fuel prices, however, will be a significant controlling factor in determining the future level of aviation activity. The following forecasts assume a 22 percent increase in oil prices and an 11 percent inflation rate for the 1980–1981 period. Fuel price increases will be less dramatic in subsequent years, but are expected to average about 9 percent annually during the 1980–1992 forecast period. This includes the effect of price increases in domestic and imported oil, but not the impact of possible taxes on aviation fuels.

FAA Forecast of U.S. Domestic Civil Aviation

[Figures in millions]

	Fiscal year 1980	Fiscal year 1992	Percent change
Air Carriers:			
Revenue passenger enplanements	290.5	481.1	+66
Revenue passenger miles*	201.9	352.7	+75
Itinerant aircraft operations	10.3	12.5	+21
Jet fuel (gallons)	10,370	12,658	+22

*Note: Revenue Passenger Miles expressed in billions.

FAA FORECAST OF U.S. DOMESTIC CIVIL AVIATION

[Figures in millions]

	Fiscal year 1980	Fiscal year 1992	Percent change
General aviation:			
Hours Flown	42.1	64.3	+53
Itinerant Aircraft Operations	29.4	43.9	+49
Jet Fuel (Gallons)	909	1,851	+104
Aviation Gasoline (Gallons)	522	790	+51

Given the above estimates, air carrier revenue passenger enplanements and revenue passenger miles are expected to increase 66 percent and 75 percent, respectively, over the 12-year forecast. Itinerant aircraft operations will rise 21 percent for air carriers and 49 percent for general aviation. As expected, general aviation jet fuel consumption increases significantly more than aviation gasoline as the use of turbine-powered aircraft increases.

As noted earlier, civil aviation fuel consumption increased 25 percent over the past 10 years. FAA forecasts indicate that aviation fuel use will again increase 25 percent over the next decade. In light of a worldwide decreasing supply of petroleum, the development of alternative aviation fuels becomes increasingly important. The conservation and improved efficiency of existing fuels is also of primary concern to the viability of the aviation industry.

Contribution of Air Transportation

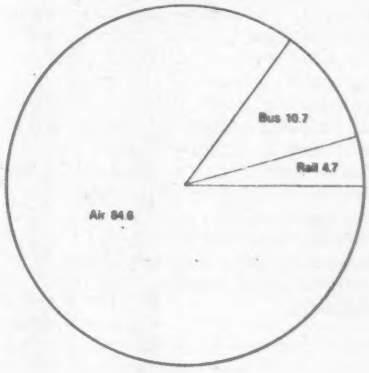
The airlines and general aviation together make up the Nation's balanced air transportation network—the safest, most dependable and most efficient in the world.

Scheduled air service is the foundation of the Nation's public intercity passenger system as shown in Figure 6. The system serves a comprehensive national network of 58,000 city pairs with 12,500 daily flights. In 1979, the airlines moved 284 million passengers a year at 735 airports. General aviation serves these airports plus an additional 14,000 airports around the country linking these cities with vital commercial air transportation. Air service has enviable records for safety, punctuality, comfort, and cleanliness. Furthermore, lower trip time is a fundamental element that differentiates air service from ground transportation. The speed of air transportation improves business opportunity and productivity which in turn benefits the Nation's economy. Also, speed is important in many family travel situations. Another major advantage of air travel is the flexibility which occurs because there is no need for right of way, i.e., aircraft operators can quickly and easily change markets, capacity, service, etc., in response to consumer demand. This is not true of rail, water and highway travel.

FIGURE 6

Distribution of Intercity Passenger Travel By Common Carrier

1979 Passenger Miles



A healthy aviation industry also assists the foreign trade balance of payments. Airline competition in the United States has fostered a manufacturing industry whose products dominate world air transportation. In 1979, over 70 percent of the active free-world turbine-powered air carrier fleet were of U.S. manufacture. General aviation also contributes significantly to the U.S. balance of payments. Approximately 90 percent of the world's general aviation fleet were built in the United States.

The private automobile dominates short distance intercity transportation. The only substantial public service challenge is from air transportation on medium and longer distance trips. While a fully loaded automobile is generally fuel efficient, low occupancy automobile travel is neither cost effective nor fuel efficient. Since 87 percent of air passengers travel singly or in parties of two, energy may not be conserved if fuel allocations disrupt air service and the auto is used as an alternative mode.

The following table shows relative fuel efficiencies for the various modes based on the actual number of passenger-miles traveled in 1978. As noted earlier, speed is a fundamental element that differentiates air service from the ground modes. Passenger miles per gallon fails to reflect the value of a passenger's time in its measure of efficiency. While a bus is by far the most fuel-efficient mode, its passengers are limited to shorter distances than air travelers when time is important. Numerous studies have been done to develop a more satisfactory measure of efficiency, however, to date, there is no generally accepted measure of the value of passengers' time across the modes. Nevertheless, the DeOT/FAA supports the use of the most efficient means of transporting people and goods be it by air, rail, ship or highway. The improved efficiency of all those modes is a common objective. One final note is that when evaluating the total energy costs of a transportation mode, direct and indirect costs must be included. Indirect costs comprise, among other things, the energy costs of installing rails and highways.

Passenger Miles Per Gallon*

[Intercity travel, 1978]

Class I Bus	119.00
Rail	45.04
Automobile	43.32
Scheduled Air Carriers	23.87

*The equivalent level of BTU's was used to determine the "Passenger Miles Per Gallon" figure for rail.

The U.S. airlines have established an outstanding energy conservation record since the 1973 oil embargo. In 1979, the scheduled airlines used 4.7 percent more fuel than in 1973, but carried 91 million more passengers (a 47.3 percent increase). Domestic revenue ton-miles per gallon (RTM/G), a widely used measure of air carrier fuel efficiency, increased 35 percent from 1973 to 1979.

The substantial improvements in air carrier fuel efficiency to date have resulted primarily from reducing the number of flights as a result of the oil embargo (thus increasing load factors); the voluntary grounding of fuel-inefficient aircraft and airline investment in new, more fuel-efficient aircraft; and the efforts by the Federal Government and the industry to improve air traffic control and aircraft operating procedures. The rapidly escalating price of fuel has provided the incentive for continued efforts in these areas. In this regard, it is important to note that many people criticize the airlines for flying with empty seats. Actually, the domestic scheduled airlines have consistently recorded the highest load factor of all intercity public transportation modes (see Figure 7). In the future, there is a practical limit to raising seating density and to increasing load factors. Further improvement in aviation fuel efficiency, therefore, will require dedicated efforts by all segments of the industry.

Although there is no comparable measure of general aviation fuel efficiency (revenue ton-miles are meaningless for general aviation), this segment of the aviation industry has also implemented numerous programs to conserve energy. Most of these programs have focused on educating pilots in the most fuel-efficient operating techniques such as proper leaning procedures, engine maintenance, etc. FAA will continue to support these efforts wherever possible. General aviation serves an important function by providing direct origin-destination travel to non-airline markets or at non-airline times. In addition, general aviation provides ambulance, agricultural, firefighting, aerial surveying, banking and postal services as well as numerous other functions for the Nation's economy.

Aviation Fuel Supply Conditions

In the past, aviation fuels were subject to mandatory price and allocation regulations (administered by the Department of Energy). The allocation program regulated producers, distributors, and sellers of petroleum products with respect to the volumes of each regulated petroleum product they could provide to various consumers or classes of consumers. The pricing program was more complex due to the varying treatment of different classifications of crude oil by the producers. This pricing problem did not occur for aviation fuels because very few nonproduct costs were involved. As long-term, fixed price fuel contracts expired, they were replaced by contracts of shorter duration without fixed prices. The aviation fuel allocation system also worked well as long as demand patterns remained stable. As a result of the Airline Deregulation Act of 1978, numerous requests for route changes were filed and the allocation system broke down. The airlines' allocation problem was relieved when the price and allocation regulations for aviation fuels were repealed.

On February 26, 1979, the mandatory price and allocation regulations were revoked for kerojet fuel and aviation gasoline. Naptha jet fuel (use primarily by the military) was decontrolled on October 1, 1976. The current status, therefore, is a free market situation regarding price for all aviation fuels which will remain in effect unless standby regulations are fully or partially activated.

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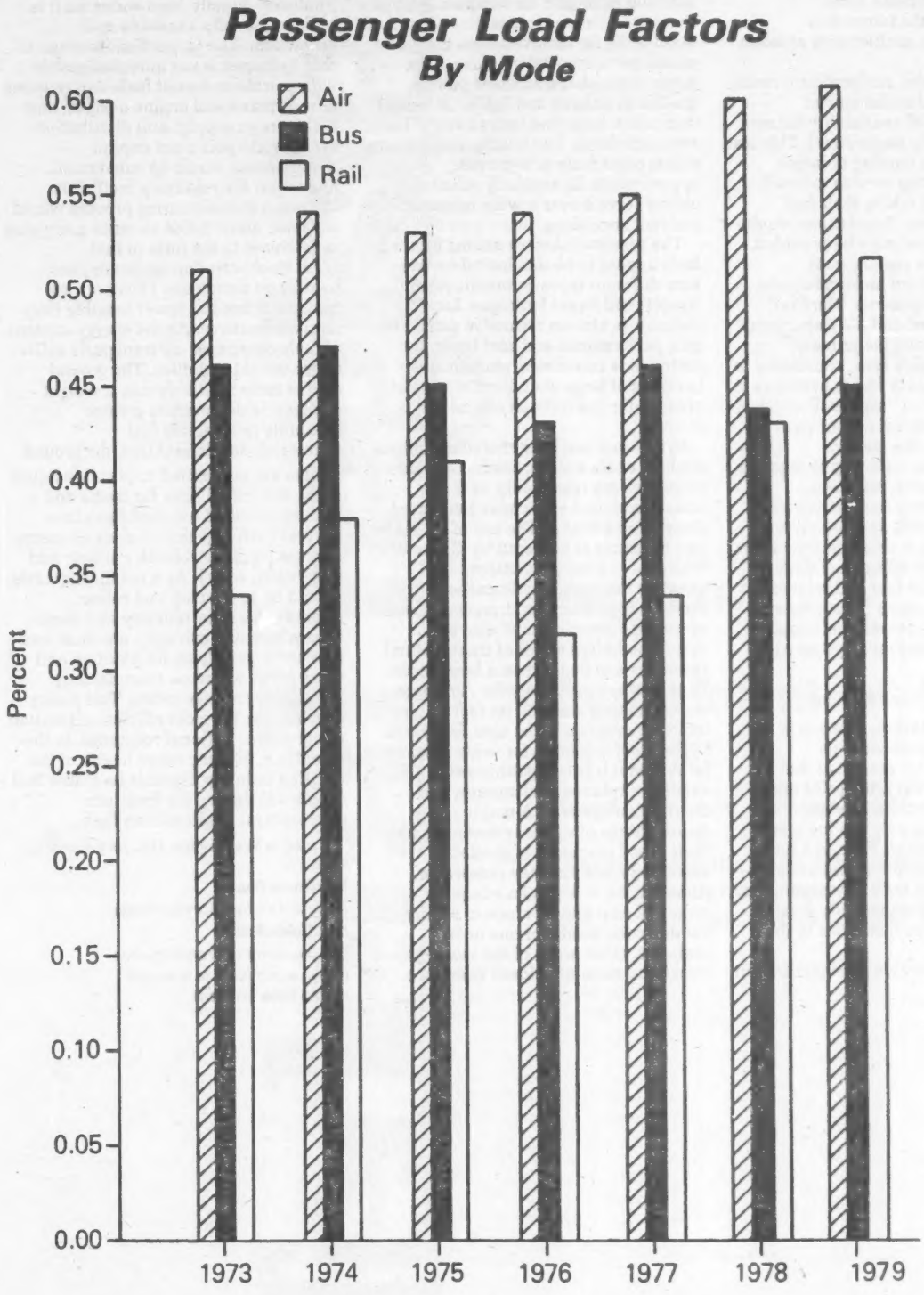
FIGURE 7



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Agency (EPA) requirements, unleaded motor gas will become more predominant in the future thus exacerbating the conflict with aviation gasoline.

A problem which surfaced as a result of the Airline Deregulation Act concerned the fuel availability for new carriers (primarily commuters). This was precipitated by a number of larger carriers terminating service to small communities and taking their fuel supplies with them. Regulations require that replacement service be provided, but in some cases replacement commuters could not make adequate fuel supply arrangements. The Civil Aeronautics Board and the Department of Energy, who have the primary responsibility in this area, coordinate to ensure that adequate fuel is available to guarantee a level of "essential" service; otherwise, the original carrier must continue to serve the market.

The FAA has no authority to regulate fuel producition or distribution, however, the agency has coordinted informally with DOE on aviation fuel problems or request received from users. DOE maintains an airline fuel desk to handle requests for fuel and related problems. FAA actions focus primarily on monitoring the overall fuel supply and price conditions on a systemwide basis.

Alternative Fuels Development

As mentioned earlier, aviation is currently totally dependent on petroleum fuels. It is predicted that by the turn of the century, the price and availability of petroleum-based products, including aviation fuels, will be at the critical stage. Research has been done to develop alternative fuels, however, alternate fuels for aviation do not appear to be economically feasible or available in large quantities in the near term.

Petroleum-based aviation fuels exhibit characteristics which are amenable to safe and economic air tansport. Jet fuel density and energy properties allow fuel tanks to be far removed from the passenger compartment. Also, for a given payload, the airframe can be smaller in volume and lighter in weight than when large fuel tanks have to be accommodated. The boiling and freezing points of jet fuels also provide opportunities for regularly scheduled airline service over a wide range of ambient conditions.

The practical choices among future fuels appear to be dominated by two very different types: synthetic Jet A (synjet) and liquid hydrogen. Liquid methane is also an attractive possibility on a performance and cost basis, but restrictions concerning storage and handling of large quantities in populated areas make it a difficult choice for aircraft.

Synjet fuel can be manufactured from coal, oil shale and tar sands. Coal-based processes are reasonably well understood, and some have been used since World War II. The use of oil shale and tar sands is hindered by difficulties which have been encountered in exacting the usable hydrocarbon product. Significant environmental and economic obstacles must also be overcome before either of these natural resources can be used on a large scale. Despite these problems, the Air Force could be using shale oil jet fuel in limited quantities in the next few years.

The chief incentive for using synthetic Jet A is that it is compatible with existing airplanes, fuel storage, and distribution systems. A major disadvantage of synjet is that none of these fossil resources is available universally, nor are they renewable. Although the U.S. has an adequate supply of coal and oil shale to satisfy our domestic needs for one or two centuries, other areas of the world have little or no remaining fossil resources.

On the other hand, hydrogen can be produced directly from water, so it is both universally available and renewable. The major disadvantage is that hydrogen is not interchangeable with petroleum-based fuels and requires new airplane and engine designs, and fuel storage, supply, and distribution systems. Airport plant capital requirements would be substantial. Moreover, the relatively inefficient hydrogen manufacturing process would consume about twice as much energy as is delivered in the form of fuel.

All transportation modes depend heavily on petroleum. However, air transportation has fewer feasible near-term alternatives. As the energy content of fuels decreases, air transports suffer major weight penalties. The ground modes incur relatively minor weight changes, which permits greater flexibility in selecting fuel characteristics. In addition, the ground modes are not limited to portable liquid fuels. Electrified lines for trains and bettery-powered automobiles allow several exchangeable choices of energy sources (coal, petroleum, nuclear, and eventually, solar). As a result, emphasis should be to develop and refine alternate fuels for industry and those uses where it is currently practical and to reserve petroleum for aviation and other areas where no economically feasible alternative exists. This policy provides for the most efficient allocation of our scarce national resources. In the meantime, the long range health of the aviation industry depends on stable fuel supplies including the long-term development of alternative fuels.

Issued in Washington, D.C. on January 13, 1981.

Langhorne Bond,

Federal Aviation Administrator.

Neil Goldschmidt,

The Secretary of Transportation

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